Volume 27 June, 1941 *Number 6*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Coal Mining

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

GENERAL RECOMMENDATIONS
TEXACO LUBRICANTS
FOR COAL MINING MACHINERY

BELOW GROUND

Drills, Hammers, Stoppers, Punchers and Picking Machines

ROTATING AND RECIPROCATING ELEMENTS	Texaco Algol Oil C / Texaco Ursa Oil C
Under-water Conditions	Texaco Stazon B or C or / Texaco Draco Cylinder Oil
FITTINGS AND REDUCTION GEARS	Texaco Star Grease No. 00 or / Texaco Star Grease No. 1

Mine Compressors

CYLINDERS AND CRANKCASE	Texaco Cetus Oil or / Texaco Alcaid Oil

Cutting Machines

ELECTRIC MOTOR BEARINGS	
Oil Lubricated	Texaco Aleph Oil or / Texaco Black Oil S or 747 Oil
Waste Packed *(Grease Lubricated)*	Texaco Wool Yarn Grease or / Texaco Stazon C
Ball and Roller Bearings *(Grease Lubricated)*	Texaco Starfak Grease No. 2 or No. 3 / Texaco Marfak No. 1 or No. 2
PLAIN BEARINGS	
Oil Lubricated	Texaco Aleph Oil or / Texaco Black Oil S or 747 Oil
Grease Lubricated	Texaco Star Grease No. 1 or / Texaco Star F Grease No. 1
ENCLOSED GEARS	Texaco Thubans or / Texaco Pinnacle Mineral Cylinder Oil
EXPOSED GEARS	Texaco Marfak No. 1 or / Texaco Crater No. 1
CUTTER CHAINS AND SPROCKETS	Texaco Black Oil or / Texaco 747 Oil
WHEEL BEARINGS *(Oil Lubricated)*	Texaco Aleph Oil / Texaco Black Oil S or / Texaco 747 Oil
BALL OR ROLLER BEARINGS *(Grease Lubricated)*	Texaco Starfak Grease No. 2 or 3 or / Texaco Marfak No. 2
CONTROLLER FINGERS	Texaco Starfak Grease No. 2 or / Texaco Star Grease No. 1

Loaders

HYDRAULIC SYSTEM	Texaco Hydra, Cetus, Alcaid, Nabob or Aleph Oil or / Texaco Anser Oil
TRANSMISSION CASE	Texaco Thubans, Stazon C, / Texaco 747 Oil or Marfak No. 1
Gathering Head Case	
Swivel Pin Housing	
Crank Pin	
Feed and Reverse Mechanism	

Motor Bearings

BALL AND ROLLER BEARINGS	
Grease Lubricated	Texaco Starfak No. 00 or No. 2 or / Texaco Star Grease No. 00
PLAIN BEARINGS *(Oil Lubricated)*	Texaco Aleph Oil
ALL OTHER BEARINGS	Texaco Stazon C or / Texaco Star Grease No. 00
ALL GREASE FITTINGS	Texaco Marfak No. 1 or / Texaco Star F Grease No. 1
ROLLER CHAINS	Texaco 747 Oil
EXPOSED GEARS	Texaco Crater

(Continued on 3rd Cover)

LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

Published by

The Texas Company, 135 East 42nd Street, New York City

Vol. XXVII June, 1941 No. 6

Change of Address: In reporting change of address kindly give both old and new addresses.

Coal Mining

"COAL AS FUEL" was the predominating thought concerning this most valuable mineral until chemistry discovered that by destructive distillation a variety of extremely useful chemicals could be derived by treating certain grades of coal in this manner instead of burning them for heat, light and power. It is a tribute to the chemical engineer and his foresight in looking beyond the coke oven for those gases which used to be wasted, or at best just burned.

But coal is still preeminently a fuel to the layman—even though oil and gas are supplanting it in so many homes. And yet, as a fuel or as a source of chemicals, coal must still be mined in the conventional manner. While mining procedure has changed but little during this transition in the field of chemistry, mining machinery, whereby the handling of coal has been largely mechanized, has been highly perfected. Mechanisms and more intricate parts are better protected, and coordination of operations has been developed to an amazing extent, for the production of coal has not decreased even with the swing to other fuels.

All this has required study of these methods and machines by the petroleum industry, for their coordinated functions are only made practicable by the utilization of lubricants and means of lubrication suited to the prevailing operating conditions. To be sure, these latter have not changed, but their effect upon modernized mining machinery may be more severe today if lubrication is not effective.

This means that the lubrication of mining machinery must be approached only after thorough knowledge of machine design and a comprehensive understanding of the effect which water, heat, pressure, and acid conditions may have upon the lubricants proposed. The petroleum refiner has met this problem by arranging refinery procedure so as to produce lubricating greases, machine oils, and gear and wire rope lubricants which will withstand the aforesaid operating conditions. That he has succeeded is indicated by the upward slope of the coal production curve and the financial statements of those heavy machinery builders who have produced the mechanisms to make this production possible. In a day of national emergency, all concerned are entitled to honorable mention.

This attitude toward selection of lubricants is a decided credit to machinery builders and mine operators. The old order of events has passed. Today all concerned appreciate the value of lubrication as the outstanding factor in reducing power consumption and the cost of machinery maintenance. It is obvious that power consumption may sometimes be abnormal, even where lubrication is entirely effective, if lubricants of too heavy body are used. This will be particularly true where gearing is concerned, or in automatic lubricating systems in cold weather. For this reason the lubrication engineer should be frequently consulted by both machine designers and mine operators; his knowledge of the physical characteristics and lubricating ability of his various products must be utilized to make low cost production practicable.

AT THE MINE

Mining of coal is broadly classified as involving strip or shaft operations according to the proximity of the coal to the ground surface.

In strip mining the covering layer of rock and earth needs only to be stripped off, after which open mining is practicable. The dragline scraper and power shovel are widely used in strip mining; otherwise but little hoisting or loading machinery is necessary. In shaft mining, however, it is necessary to tunnel into the ground at varying angles according to the surveyed location of the coal seams and the contour of the surface.

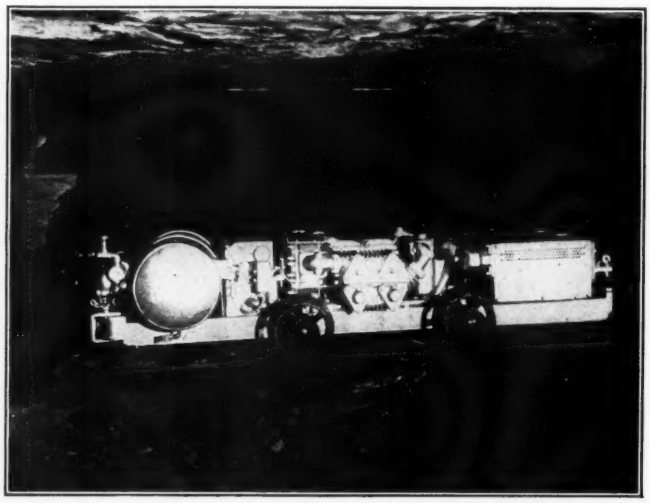
Coal mining begins at the face of the vein or seam. Here the coal must be broken away and at the same time broken up into sizes convenient for handling. The machinery required will depend upon the type of coal. Anthracite is broken out from the seams by blasting after suitable drilling with air or electric drills. Bituminous coal is mined by cutting, picking or punching machinery. Then coal handling to the mine cars is necessary. Here electric power is widely applied in modern mining, the electric locomotive hauling the cars to the breaker or tipple where sizing and sorting and cleaning are done.

Power Development

As air or electric power predominate, compressor and motor lubrication must be most carefully studied.

AIR POWER

Air tool lubrication can be improved by locating the source of air supply as close to the



Courtesy of Ingersoll-Rand Company

Fig. 1—View of an I-R mine compressor.

tools as practicable. In this way possibility of rust accumulations within long lengths of pipe, and subsequent interruption of the functioning of tool mechanisms can be reduced. This has been accomplished by locating compressor rooms below ground or by use of the mobile type of motor driven mine compressor of low head construction which can be readily moved through galleries or from one level to another, with minimum change in piping connections.

Mine compressors are designed to exclude dust as far as practicable. The working parts of portable machines are very frequently provided with sheet metal covers, and air filters are quite generally used to remove abrasive dust from the intake air. This assures protection of the compressor parts and tool mechanisms and also reduces the possibility of accumulation of abrasive or gummy deposits.

The Compressor Oil

Cylinder lubrication requires an oil of very high lubricating ability, for minimum quantities must be used; furthermore, the oil must resist breakdown when exposed to heated air, in order to reduce the possibility of gum formations and mechanical failure of any part of the system. The degree of refinement, the tendency to form carbon deposits, the flash point and viscosity of the oil must all be considered in determining the suitability. Refinery procedure can be measured by the integrity of the refiner.

Obviously the oil must not break down, otherwise deposits of carbon may develop (plus dirt) on the valves or in the discharge lines. It is impossible to prevent this where adverse conditions prevail, for mineral lubricating oils, regardless of their base or nature, will decompose to volatile products and carbon when subjected to hot air under pressure. On the other hand, the extent of this decomposition will depend upon the length of time the oil is exposed to such heat. With oils of the same degree of refinement, the one which remains in the compressor cylinder or on the discharge valves the longest will form the greatest amount of carbon. At the same time some oils will develop odors which are objectionable to workers in confined spaces.

On the other hand, analysis of numerous so-called carbon deposits has proved them to consist more of dirt than of carbon, the whole being held together by gummy matter from decomposed oil, especially where the latter has a wide range of distillation, high end point, or too high a viscosity. Such an oil will not vaporize cleanly, and when it breaks down it becomes sticky and collects dirt brought in by the air. The longer such an oil remains in the compressor, or the

greater the volume of oil involved, the more carbon will ultimately be developed with greater possibility of compressor difficulty.

Carbon in its true form may develop in air compressor cylinders in a hard mass, or it may be produced in the form of dust and pass out with the air. In the latter case it will often collect in pockets, elbows, or on sharp edges and become mixed with dirt taken in by the air as well as with oil which has been vaporized in the cylinder and later condensed at these points.

Mine Drills and Other Air-Powered Tools

Lubrication of air-powered mining equipment is effected at the tool itself. So the means of lubricating the mine drill and picking or punching machine have been given very careful study. The mechanisms are complicated, being composed of numerous small parts which may readily become inoperative if improperly lubricated. In studying means of lubrication, it has been found that the air provides an excellent medium for carrying lubricant to certain of these parts. This is accomplished by locating a suitable lubricating device in the air line.

The cylinders, pistons and rifle bars in the reciprocating type of drill are lubricated by the air line oiler, using an oil of light to medium viscosity of either straight mineral or compound nature according to the moisture content of the air. Gears and crankcase bearings, in turn, are served by a light or semi-fluid grease. As ball and roller bearings are widely used on crankshaft and connecting rod assemblies, this grease should be resistant to breakdown and capable of protecting these bearings dependably. At best, mine drill lubrication is a problem, as the mechanisms operate under conditions which many other machines are designed to function apart from, viz., thrust, impact and hammering.

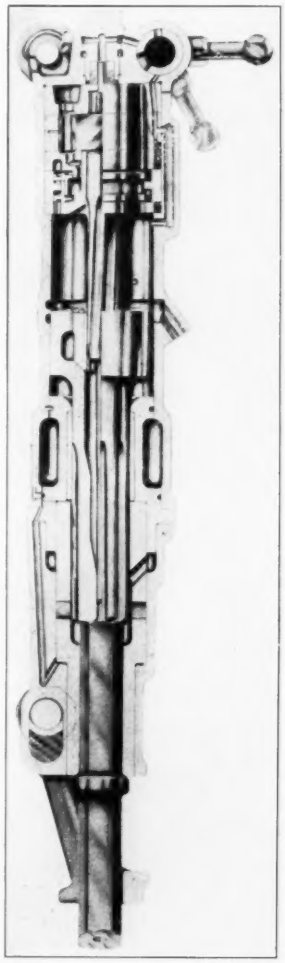
Rust Prevention and Heat Resistance

The air conditions which prevail in many coal mine operations have caused rust prevention to be regarded as one of the most important characteristics in a drill or air tool lubricant. Almost as important is "adhesiveness" and "heat resistance," where it becomes necessary to protect tool mechanisms such as the rifle bar against overheating and checking.

The Detriment of Water

Water will impose a severe duty on any mine drill lubricant, however suited it may be to the actual operating requirements, due to the tendency it may have to wash off the lubricating film from wearing surfaces. It is for this reason that compounded lubricants, i.e., mineral oils containing more or less animal oil or soap in compound are recommended for the lubrication of drills and other equipment, where operating with water. Lubricants of this nature emulsify with water, by virtue of their fatty content, creating an adhesive emulsion which sticks tenaciously to all wearing elements and resists the washing effects of water.

Compounded lubricants are often recommended for air drills wherein water is used for washing cuttings from the hole, in much the same manner as a soluble oil solution washes metal cuttings away from the tool in the machine shop drill, etc. Where pneumatic tools are designed to function dry, however, they should be absolutely dry, that is, as free from moisture as possible. On such equipment straight mineral lubricants are generally regarded as most satisfactory.



Courtesy of Sullivan Machinery Company

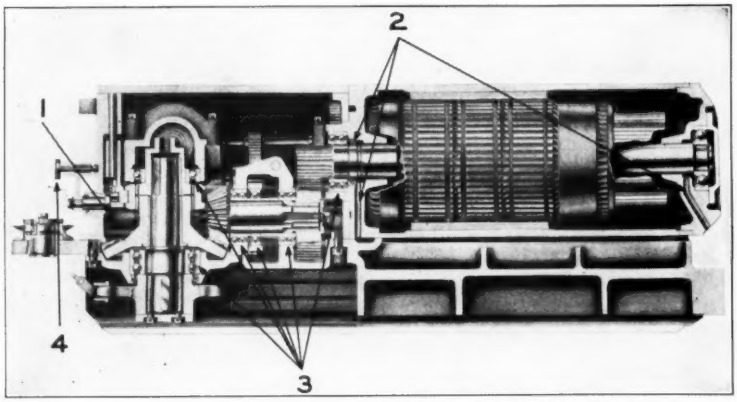
Fig. 2—The Sullivan L-57 rock drill with built-in oil reservoir which holds enough oil for four hours.

Keep the Air Clean

Foreign matter, such as coal or rock dust, may gain entry through careless handling of the drill or pick. Some dirt may also be carried through the drill by the air itself. Any such foreign matter will be detrimental and cause abnormal wear. Every attempt is normally made to obtain clean, pure air. It is not always available, however, depending upon the location of the compressor, the air intakes, whether or not air filters are installed, and the cleanliness of the air coolers and air lines.

The portable mine compressor eliminates line troubles. Regardless of the system of compression, however, the possibility of particles of rust being carried in by the air may often prevail.

especially where lubrication has not been adequate in the protection of those parts of the system exposed to moisture. Then, too, particles of rubber from the air hose and gaskets may find their way into the air passages and cylinders, along with other foreign matter, to interfere materially with the free operation of the drill mechanism. To eliminate such troubles a wire strainer of suitable fineness located in the inlet pipe has been found advantageous in removing much of the above mentioned foreign matter from the air prior to contact with the tool mechanisms.



Courtesy of Sullivan Machinery Company

Fig. 3—Working details of the Sullivan Shortwall coal cutter. (1) denotes point for splash lubrication; (2) oil seals and outlets for motor protection against entry of oil; (3) the ball bearings on all power transmitting shafts and (4) the cutter chain clutch lever.

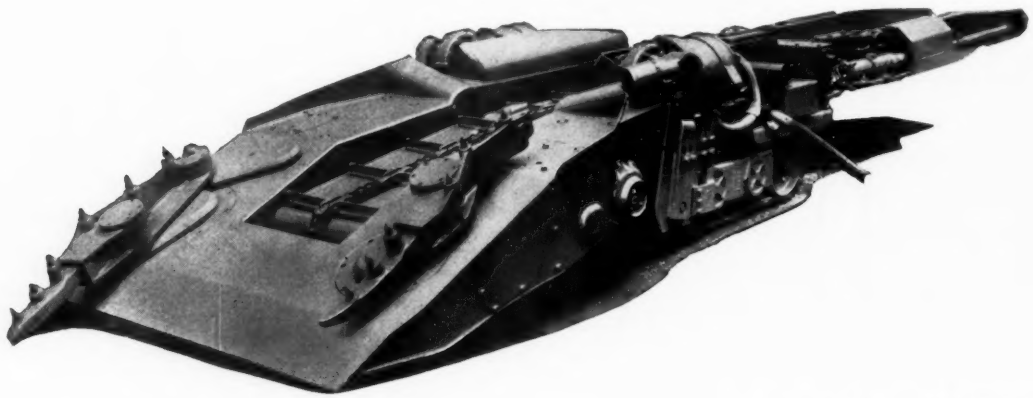
COAL CUTTING

In contrast with the drill, which is so widely used in the anthracite fields, the coal cutter is employed in the bituminous or soft coal fields. Coal cutting is a heavy duty operation which imposes severe loads upon the chains, gears and bearings which comprise the machine. In turn, these loads react upon the lubricants, so selection and application of the latter is most important. Primarily they must be carefully refined products adapted to the design of the parts on which they are to be used. Some machines can be lubricated by a soft grease or an oil of medium heavy body, i.e., ranging in viscosity from 300 to 500 S.S.U. at 100 degrees Fahr. On other equipment where gears and bearings are lubricated by the same system, a heavier product is generally used, such as a light to medium gear oil, or a steam cylinder oil.

The coal cutter operates on trucks driven through a worm and gear, with chain connections to the wheels. Chain lubrication may sometimes present a problem as the chains are often exposed and subject to the abrasive effects of dust. So cleaning and periodic lubrication are important. Both objectives can be accomplished if it is practicable to soak the chains in oil at regular intervals. Otherwise, lubrication can be effected by painting the links with black oil of sufficient fluidity to develop a certain amount of washing action.

Parts Replacement

Parts replacement is of considerable importance to the operator of coal cutters, or, in fact, any type of mining machinery, for it may become quite an item on the cost records. Lubrication reduces this item because of its ability to counteract the effects of wear, just as it reduces power consumption. Wear will



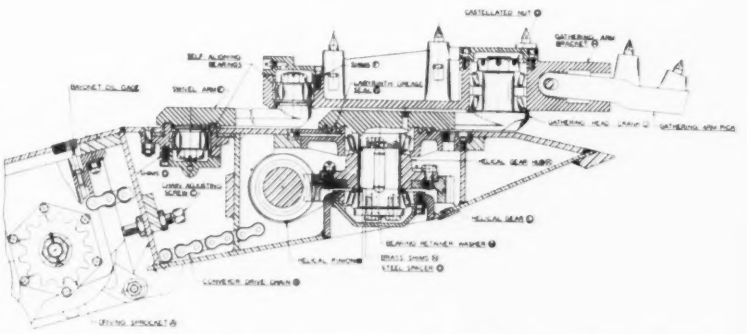
Courtesy of Joy Manufacturing Company

Fig. 4—The Joy standard 14 BU loader.

often be extensive on the moving elements of any coal mining machine, regardless of the attention given to lubrication, for the presence of excessive amounts of coal dust and other abrasive matter, and the possibility of dampness interfere seriously with retention and distribution of lubricants, unless parts are very tightly enclosed.

Even then certain gears and bearings will wear more than others. In such cases the best to be expected from lubrication is that it will reduce the rate at which such wear takes place, enabling gears to run in proper mesh as long as possible, and increasing the life of bearings. As improper meshing of gear teeth develops, or bearing clearances become too great, power losses, noise and perhaps decrease in production, will occur, with subsequent breakdown and necessity for repair.

Whenever it is necessary to renew gears or bearings, it will be advisable to investigate whether or not the entire train, or all the bearings warrant renewal. Merely to install a new gear, or renew the bearing of a gear shaft will not insure correct meshing in case the companion gears or bearings are worn to any great extent. In fact, this would only lead to more rapid wear of the new element. The use of heavier grades of gear lubricants might offset high tooth clearances to a certain extent, but the increase in power consumption involved, due to possible drag might not render this economical under continued operation.

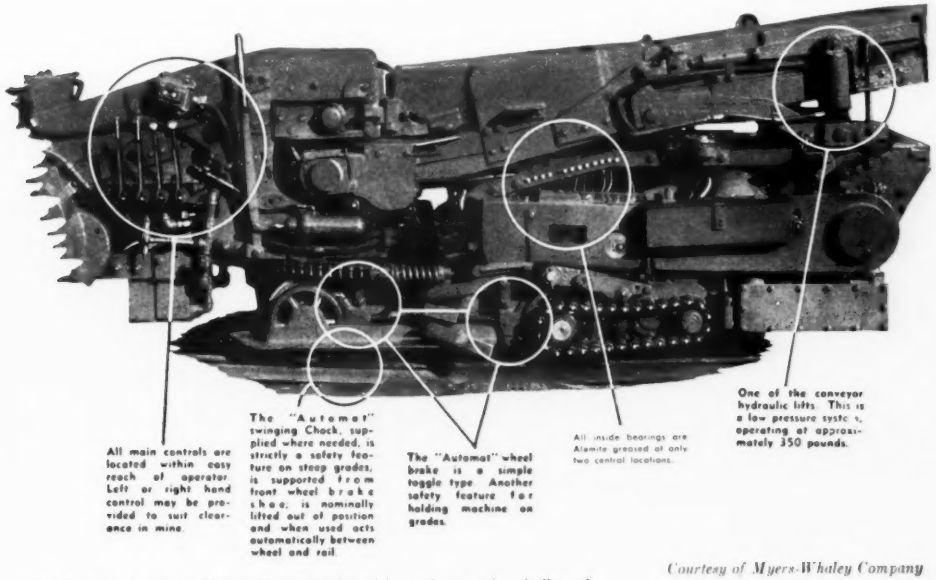


Courtesy of Joy Manufacturing Company

Fig. 5—Longitudinal section through the gathering head of the Joy 14 BU loader.

MECHANICAL LOADING

Coal must be loaded onto mine cars for handling to above-ground machinery after it has been broken away from the seam. Modern mining makes good use of the mechanical loader for this purpose. The development of this machine was a valuable contribution to the program of power mining which has become such a factor in increasing production and decreasing cost per ton. As a factor in completing the process of mechanization, it



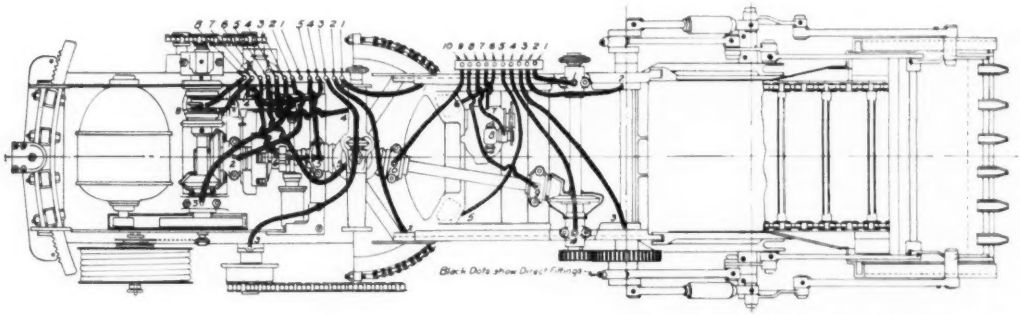
Courtesy of Myers-Whaley Company

Fig. 6—Side view of a Myers-Whaley loader with pertinent points indicated.

has also contributed to reduction in cost of lubrication per ton.

The modern coal loader is a combination gathering, conveying and materials handling device. The gathering and scraping mechanisms dig into the loosened coal and drag it onto the conveying unit which in turn delivers it to the mine cars. All this presupposes that these mechanisms must function in intimate contact with abrasive materials and often under high temperature conditions which are decidedly conducive to wear. To offset this, the gears chains and bearings must be properly lubricated at all times. In addition coal loaders which are built for hydraulic operation require a high grade lubricating oil as the hydraulic medium. At the same time this oil lubricates the interior moving parts of the hydraulic system.

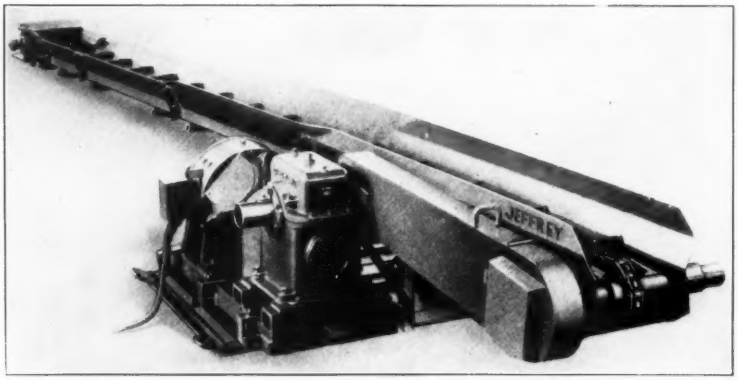
Automatic lubrication has been successfully applied to the modern loader using both oil and grease, according to the design and arrangement of the parts to be lubricated. Where the operating mechanism such as gears and bearings can be served from a central reservoir, a relatively heavy bodied straight mineral oil has proved to be suitable. The viscosity will be adequate to assure of gear tooth protection, yet the lubricant will be possessed of sufficient fluidity to enable it to carry through the bearing clearances. At the same time it will follow the chain links and rollers in a similar manner.



Courtesy of Myers-Whaley Company

Fig. 7—Lubrication chart for a Myers-Whaley automatic coal loader equipped with ball bearings. See manufacturers chart for parts identification.

Greases are also applicable to certain types of gear and chain assemblies, though they should be of comparatively light body so that they will follow or train readily with the gear teeth. Obviously, due to the possibility of lubrication being necessary at comparatively low temperatures, a grease for such service should contain a high grade of low pour test mineral oil. Otherwise, should congealment occur, lubrication might suffer, due to the grease becoming too inert to penetrate through the bearing clearances or to follow the gear teeth.



Courtesy of The Jeffrey Manufacturing Co.

Fig. 8—View of a Jeffrey type 61-AM room conveyor as adapted to conveyor mining.

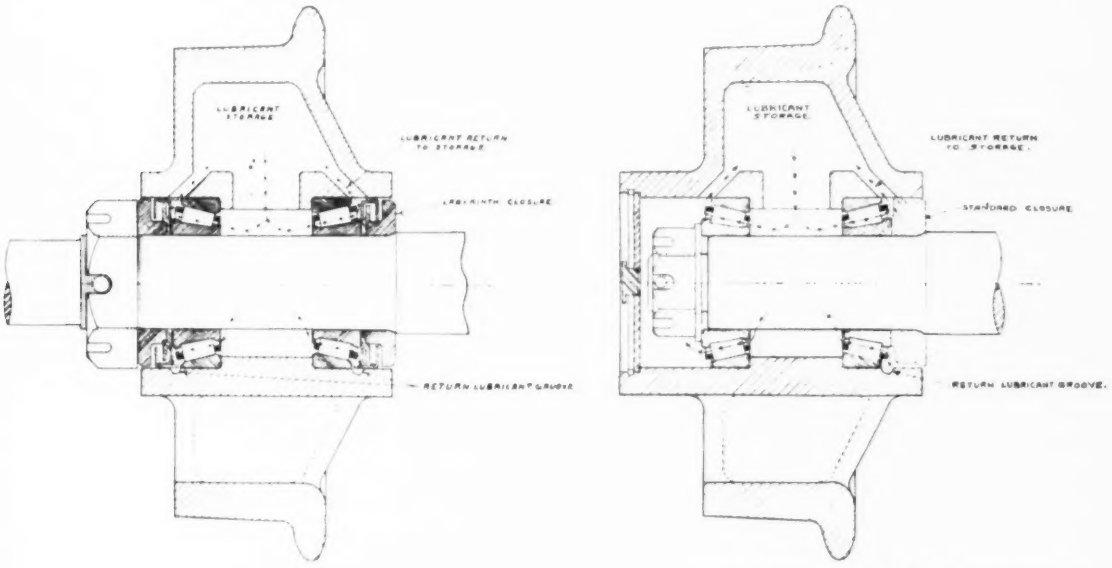
Hydraulic Operations

Hydraulic power has materially facilitated the handling of the modern coal loader. For this purpose a high grade of straight mineral oil is used. It must be capable of functioning over a wide range of operating temperatures, resistant to emulsification or sludging in the presence of moisture, and capable of lubricating all parts within the system which may require lubrication. Plungers and plunger rods must work freely at all times otherwise the purpose of hydraulic operation may be defeated.

External Parts

In addition there are also some exposed parts which must be lubricated. Their pro-

tection is most important due to the possibility of wear by contact with abrasive materials. Periodic lubrication prevails on such parts, using a medium consistency cup grease or light medium straight mineral oil according to the most helpful in this regard. Coupled with a conveyor mechanism to handle the coal either directly to mine cars or onto a gathering conveyor, it provides a rapid system of materials handling.



Courtesy of Hockensmith Wheel and Mine Car Company

Fig. 9.—Details of Hockensmith design for mine car wheel lubrication. At left is shown the stub axle box spoke wheel; at right a box spoke wheel. Note path of lubricant is indicated by arrows, and types of closures.

means provided for application. Exposed gears, however, require a heavier lubricant, of from 1000 to 2000 Seconds Saybolt Universal viscosity. Such a product resists loss by centrifugal force and sticks tenaciously to the gear teeth. It should be applied sparingly, however, as excess tends to accumulate foreign matter to ultimately cause wear or even tooth breakage if the mixture packs between the gear teeth.

CONVEYOR MINING

The sectional conveyor of either chain or belt type has been adapted to coal handling in a most unique manner. Installed adjacent to the cutter at the face of the seam it presents a novel method of handling either bituminous or anthracite in any phase of mining. It can be made supplementary to a mine car or hoist system or in some cases installed as the primary means of coal handling from either a shaft or strip mine to the breaker or point of shipment.

Cutting, loading and conveying are operations which are of necessity inter-related in coal mining. The product must be moved from the face as rapidly as it is cut or broken away, otherwise congestion will develop to retard production. The modern coal loader is

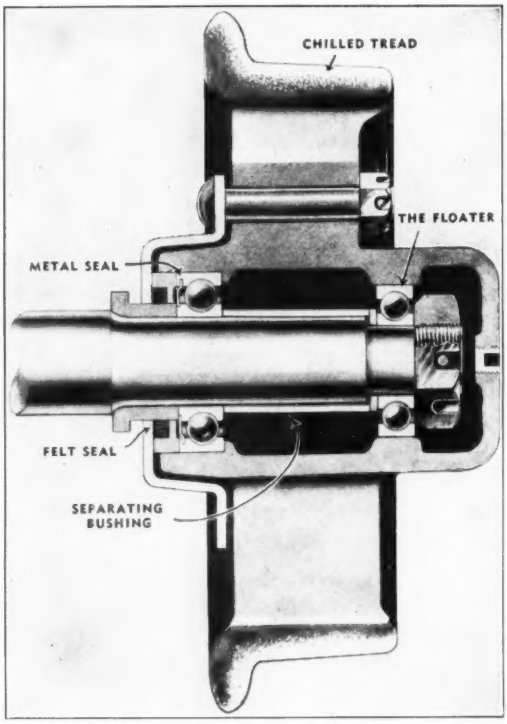
Electric power is employed in conveyor mining to drive the enclosed worm reduction gear, which in turn drives the conveyor unit by chain connection at a predetermined speed, according to the rate of loading. As the drive assembly is carefully enclosed, lubrication is amply protected and can be maintained by conventional lubricants which are suited to the operating mechanisms, viz.: a medium bodied straight mineral machine oil for ring-oiled motor bearings; a special ball or roller bearing grease for bearings of this type; and a compounded steam cylinder oil for the worm gear unit. Any attendant chain elements can be lubricated in a manner similar to other power-transmitting chains elsewhere in the mine.

TRANSPORTATION

Just as the mechanical loader and conveyor have largely supplanted manpower in loading mine cars, so has the electric or air-driven mine locomotive taken the place of the mule in subsequently handling these in the working levels. Mine cars concern us from a lubrication point of view since free rolling wheel bearings are most essential if maximum drawbar load is to be handled by the locomotive with minimum power consumption.

Mine car wheel lubrication has received con-

siderable attention by reason of the volume of lubricants required; oftentimes the largest on the lubrication schedule. So they are not passed over as just being units of the sleeve or bushing type, or perhaps designed for ball or roller bearings. We want to know more about the details of design, the provisions for lubrication, the operating conditions which may prevail and the lubrication schedule.



Courtesy of Sanford-Day Iron Works, Inc.

Fig. 10—Showing the S. & D. floater type of mine car wheel equipped with Fafnir ball bearings.

Design is of particular interest. It involves the constructional features of the plain sleeve type bearing as compared with the hollow axle type or the cavity type of wheel; likewise, the relative contrast of these sleeve type bearing details as compared with ball or roller bearing applications to mine car wheels. These are discussed primarily from a lubrication point of view.

The Plain Sleeve Type Bearing

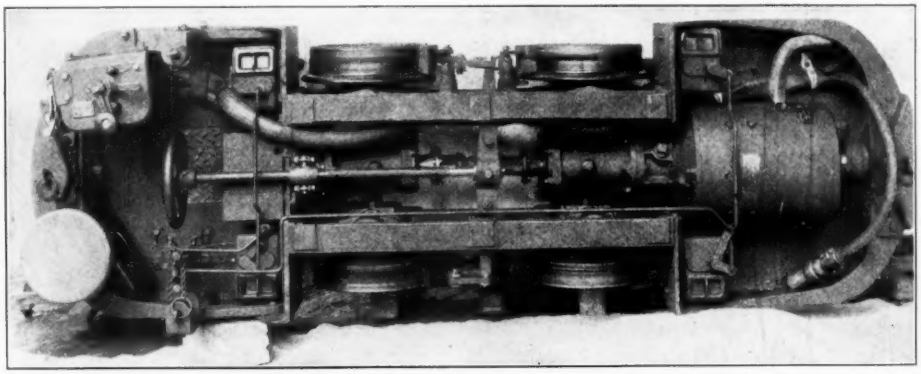
The conventional sleeve type mine car wheel bearing is patterned after the railway car wheel bearing, being designed to enable the use of oil-saturated wool yarn or waste packing.

Effective lubrication is assured by regular attention to loosening of the waste, or oil-carrying material and resaturating with a suitable grade of straight mineral machine or car oil, or a light grade of liquid grease. Matting or glazing of the oil-carrying materials should never be allowed to occur; this will reduce the capillarity of the packing and prevent free circulation of lubricant.

Hollow Axle Lubrication

This involves a hollow axle of tubular steel, the hole extending completely through the axle, which acts as a reservoir for lubricant. At the outer end of the axle, near each end is a steel cup and a spring loaded valve similar to an ordinary check valve with the exception that the guide is several inches long. A spiral spring encircles the valve stem and compels the valve to maintain a bearing on the seat, thus preventing leakage of the lubricant from the axle. At the point on the axle corresponding to the bearing surface of the wheels, the axle tube is perforated sufficiently to permit passage of the lubricant from within the axle outward to the contact surface of the axle with the inner bushing of the wheel hub.

A grease of comparatively low consistency is well adapted to this type of design, although



Courtesy of Mancha Storage Battery Locomotive Division of Goodman Manufacturing Company

Fig. 11—Chassis view of a Mancha Titan A, wormdrive locomotive.

the construction will permit of oil lubrication where desired. A charge of lubricant within the axle is capable of functioning from 3 to 4 months without renewal where axle sealing valves function effectively.

Cavity or Self-Oiling Wheels

This type of mine car wheel is lubricated from an oil or grease reservoir around the hub. During rotation the lubricant is fed to the axle or journal through port-holes staggered in the hub. Such delivery of lubricant, however, only occurs when the car is idle or running slowly. At higher speeds centrifugal force tends to carry the lubricant to the outer surface of the reservoir. For this reason, due to possibility of leakage, care should be observed in regard to the amount of lubricant used. In general, the lubricant level should be maintained on a line with the lower part of the axle when the car is at rest.

A highly refined straight mineral engine or car oil of medium to heavy viscosity normally will be best suited to the operating conditions and will insure most complete protection of the bearings. Where service in cold weather is essential, the viscosity should be reduced and the oil should have a sufficiently low pour test to insure proper flow through the distributing ports.

It is also perfectly practicable to use a mine car grease where there is possibility of oil leakage. Here again adequate fluidity at low temperatures is advantageous. Wheels designed for grease lubrication are similar to those which are to be served with oil, with the exception that frequently larger ports are used to facilitate passage of grease to the bearings.

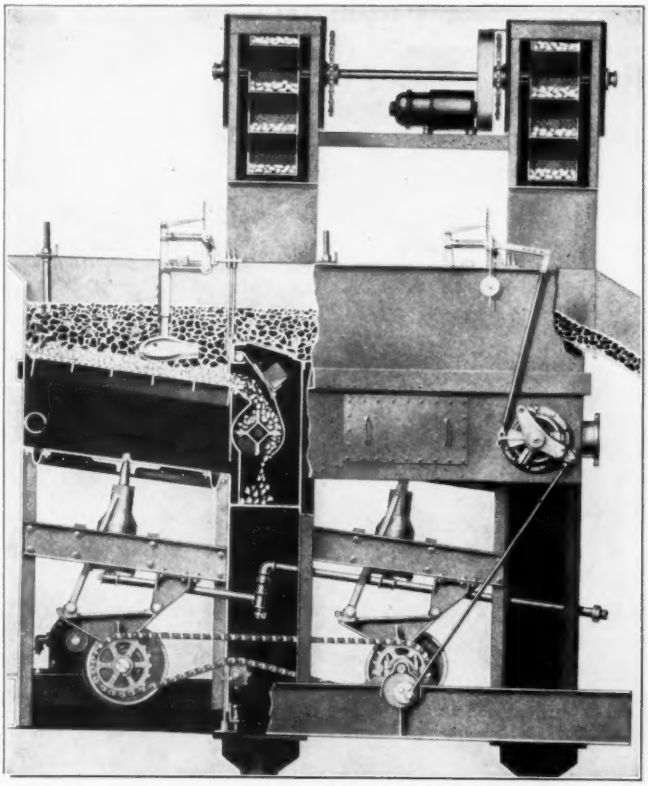
Ball and Roller Bearings

Extension of the ball and roller bearing to mine car service has been a decided step forward in the interest of positive lubrication and labor reduction.

The protective nature of the seals permits the use of high quality grease for lubrication. Normally, such a grease should be compounded with a fairly high viscosity straight mineral oil in order to obtain load carrying ability. By use of lubricants of maximum lubricating value, the frequency of relubrication can be reduced and the bearing elements more effectively protected. Where low temperature may prevail an added requirement is imposed in that the lubricant must be suited to these conditions and capable of functioning without becoming too hard.

Roller bearings are also decidedly positive, automatic and economical from a lubricating point of view. By reason of their careful construction, all lubricants used should likewise be of the highest degree of refinement, and selected with the utmost caution. The function of these latter is dual in that they must not only protect the rolling elements against corrosion, but also lubricate the contact surfaces of the bearing rolls and retainers.

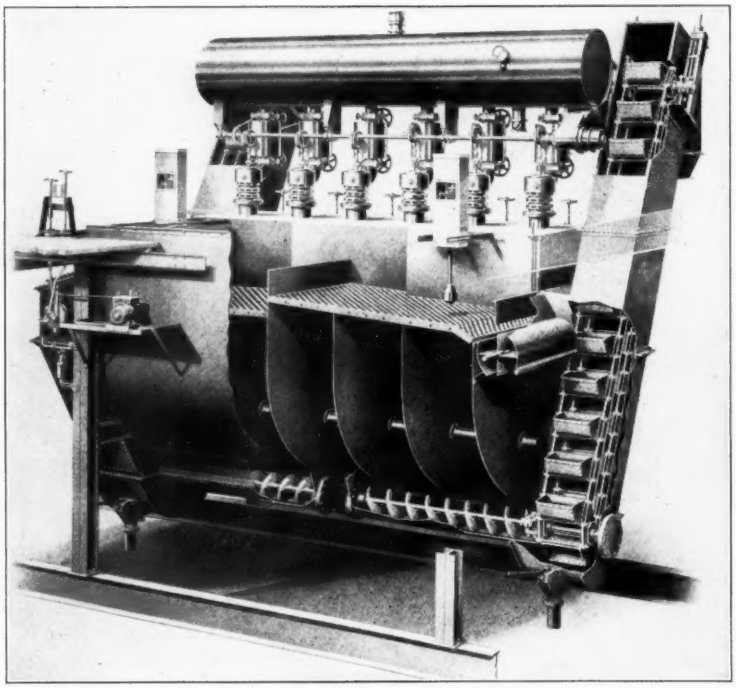
Experience has indicated that soft or semi-fluid greases are best suited for roller bearings in mine car service. Where the latter are of solid, cylindrical or tapered construction, a harder or somewhat more inert grease will be advisable than on hollow flexible bearings. It will be found that such a product will furnish a better cushion between the axle and rollers than a more plastic grease. Furthermore, it will also form a better seal against possible entry of dust, dirt or water, provided the bearing itself is equipped with a reasonably tight seal. Lubrication of flexible roller bearings,



Courtesy of The Jeffrey Manufacturing Co.

Fig. 12—Details of the Jeffrey 60" diaphragm jig for coal washing showing working mechanisms.

however, can be best accomplished with a semi-fluid or so-called liquid grease. The usual construction of such bearings provides for the hollow spaces within the rollers serving as grease reservoirs. In consequence, the lubricant must be sufficiently fluid to pass through and penetrate to all the surfaces of contact. It should never remain inert around the rollers, or tend to gum, otherwise protection of the bearings will be seriously impaired.



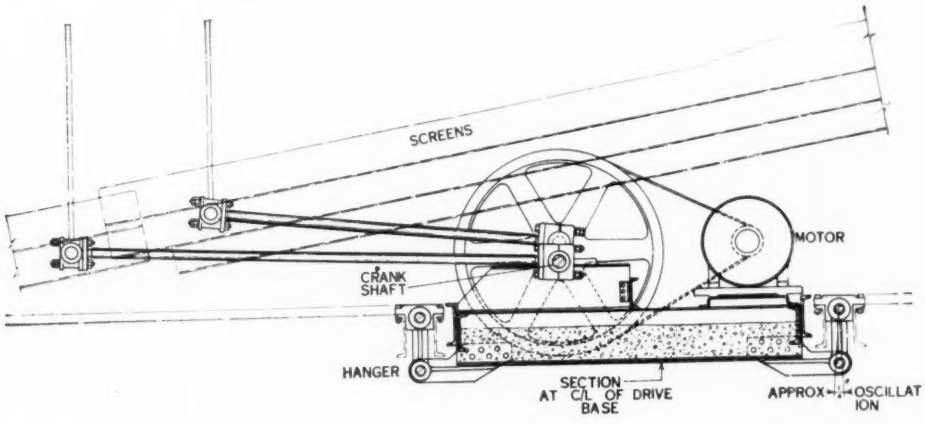
Courtesy of Link-Belt Company

Fig. 13—The Link-Belt Simon-Carves Washer showing screen and conveyor operations.

MINE LOCOMOTIVES

Mine locomotives operate under much the same conditions as do mine cars. Their lubrication requirements are, therefore, similar to other underground mining machinery. Axle bearings are lubricated according to the type of bearing; the same recommendations apply as for mine cars.

Gears, in turn, require the use of a straight mineral, gear lubricant of about 1,000 seconds Saybolt viscosity at 210 degrees Fahr. Such a product will adhere tenaciously to the gear teeth and overcome vibration and wear. This same lubricant should also be used on chain drives. On the other hand, where gears and chains are enclosed in oil-tight housings, a somewhat lighter lubricant can be used to advantage, with the possibility of reduction in drag and power consumption. The pour test of such lubricants must be considered, for the probability of low temperature service above ground will always prevail. Obviously, a gear lubricant should be capable of following the gear teeth readily, otherwise its purpose may be defeated if abnormal wear results. The degree to which satisfactory performance can be predicted is indicated by the pour test and change in viscosity with change in temperature.

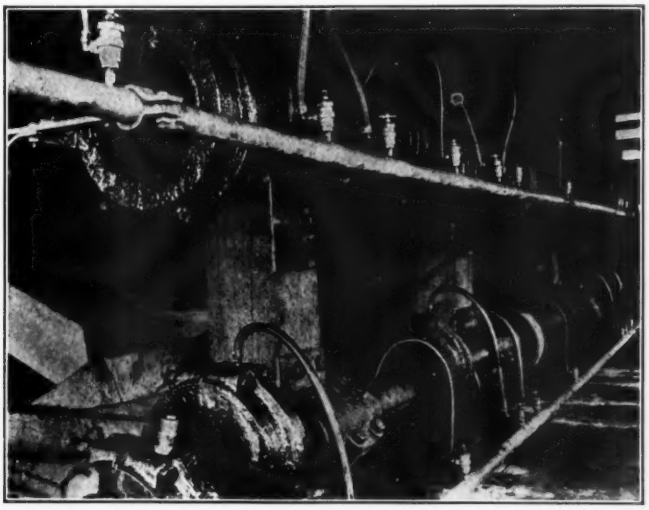


Courtesy of Link-Belt Company

Fig. 14—Sectional elevation of a Link-Belt screen of vibrationless floating drive type. Note motor and crank arrangements.

WIRE ROPE AND CABLE LUBRICATION

Wire rope is as necessary in modern mining as power. The mine hoist, aerial tramway, even some types of car-pulling mechanisms all require wire rope to enable them to function as production units. The mine hoist became more and more important as deeper shafts and the working of lower levels was adopted. Some of these operations require thousands of feet of wire rope, comparable to elevator service in a modern office building. The aerial tramway in turn may require even miles of wire rope.



Courtesy of Lehigh Navigation Coal Co. and "Coal Age"

Fig. 15—Showing an "Ideal" grease lubrication system as applied to anthracite coal screen shaker cams.

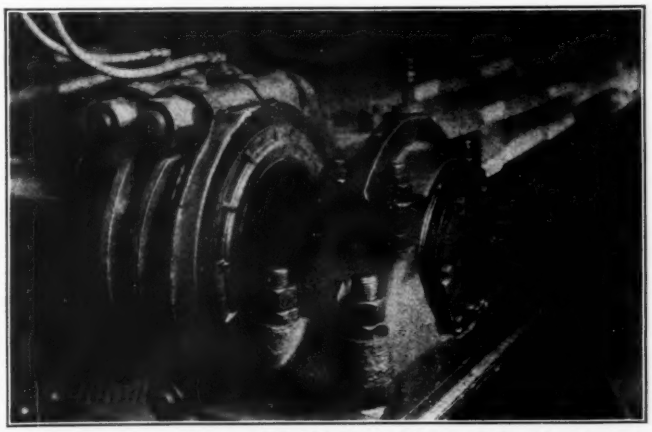
As one of the predominating pieces of equipment in modern mining, wire rope cannot be neglected. Lubrication must be maintained. When short lifts prevailed, wire rope failure might be serious, but not necessarily fatal. Today, however, rope failure may well mean men's lives, not to mention serious disruption of the production schedule.

Lubrication insures against premature wear, it retards corrosion and prolongs the life of the rope. To perform these functions most effectively the lubricant must not only prevent friction between the strands which comprise the rope, especially when the latter is bent in passing over sheaves or hoisting drums, but it must also prevent entry of water, acids or dirt which would cause corrosion or abrasion.

The desired results can be most generally attained by using heavy bodied straight mineral lubricants of good adhesive characteristics. During the course of rope manufacture a lubricant of this nature is applied to the hemp core by saturation, enabling the latter to serve as a storage reservoir from which a small amount of lubricant is squeezed whenever the rope is flexed or bent. In subsequent service the surface of the rope should be coated with a similar lubricant in order to maintain an external seal and prevent wear between the surface strands as the rope passes over the hoisting machine. The rope on an aerial tramway does not bend to as great an extent, but as it is exposed to the weather it must be equally as well sealed (by lubricant) against entry of moisture.

Strand Friction

Sliding friction prevails in wire rope service. In other words, the friction which occurs between the strands is of the same nature as that which occurs between a bearing and shaft. For this reason one should not be led to presume that because the rope is prelubricated by the manufacturer that further lubrication is unnecessary. If we do, the reserve of lubricant in the core will ultimately become exhausted, after which strand protection will cease.



Courtesy of The Philadelphia & Reading Coal and Iron Company

Fig. 16—Typical shaker cam assembly with its lubricating system as used in the St. Nicholas District Central Breaker of the P. & R. Coal & Iron Company. These cams are distinctive in that their surfaces are hardened and polished. They rotate in babbitt bronze bearings which are equipped for oil lubrication. Oil is supplied to each cam assembly individually by a flexible hose connection from a mechanical force feed oiler using a highly refined straight mineral lubricating oil within the S.A.E. 40 viscosity range.

Lubricant Characteristics

Penetration and adhesiveness have already been mentioned as essential characteristics of a wire rope lubricant. In addition to these properties, the product must not cake, gum or

ball-up if contaminated with an excess of dust, dirt or metallic particles. It must also resist the thinning-down effect of high temperature; this directly involves the viscosity or relative fluidity. Hence the importance of the viscosity as a purchase specification. It should not, however, be regarded as an indication of lubricating ability; penetration and adhesiveness are far more important. So a wire rope lubricant should not be purchased solely on a specification or price basis. Performance also must be investigated as an indication of lubricating ability. A straight mineral product is usually preferred wherein the viscosity is an inherent property. It should be free from fillers or artificial thickening materials.

The viscosity of a wire rope lubricant will range from 500 to 2,000 seconds Saybolt Universal at 210 degrees Fahr., according to the operating temperature and the intensity of the moisture conditions. The heavier grades are preferred for warm weather or conditions where there might be possibility of a lighter lubricant thinning down to the extent of dripping off. Conversely, under relatively cold conditions, a lighter lubricant should be used.

Application of Wire Rope Lubricants

High viscosity wire rope lubricants by virtue of their inertness can best be applied in heated condition. Merely to daub or paint a rope with such a product at normal temperatures would be relatively impossible. Even though the surface might be more or less coated, the possibility of penetration occurring to any extent would be remote. This latter is the secret of effective wire rope lubrication. The amount of wear occurring between the exterior of such a rope and the sheaves is not as marked as that which occurs between adjacent strands when the rope is flexed or bent, in passing over sheaves or hoisting drums.

BREAKING, CLEANING AND SCREENING MACHINERY

Modernization of breaking and cleaning machinery has resulted in a marked trend towards adoption of pressure lubrication and certain types of anti-friction bearings. Grease lubrication has been found to be very satisfactory on such machinery. It is advantageous in that grease under sufficient pressure will effectively protect the bearings against entry of coal or abrasive dust. Where certain bearings may be designed for oil lubrication, however, a straight mineral machine oil of approximately 500 seconds Saybolt viscosity at 100 degrees Fahr., will in general carry the pressures satisfactorily. Low temperatures require a somewhat lighter oil of low pour test.

Under abnormal water conditions pressure grease lubrication is decidedly effective. The grease should be highly resistant to solubility, however, due to the possibility of its having to withstand the direct washing action of water during the screening process. As a rule, a grease of medium body or consistency will be best suited to these conditions and capable of ready application by means of some form of compression cup or pressure lubricator.

Temperature must also be considered. Cam operations require study in this regard. Where cams may tend to run hot, a problem of underlubrication and abnormal wear of cams and straps may frequently develop. On certain types of cams heat and wear can be counteracted by a high melting point grease of relatively heavy consistency. The lubricating film developed by such a grease is decidedly tenacious, resistant to the thinning out effects of higher temperatures, and capable of withstanding high pressures. On other types, notably cams with hardened, polished surfaces rotating in babbitt bronze-backed strap bearings, oil lubrication is preferred, using a highly refined, straight mineral oil of a viscosity within the S.A.E. 40 range.

Gear lubrication, in turn, may develop problems whatever the method of coal treatment. Many of such gears with the accessory driving chains will operate exposed on certain machines. For these elements a lubricant must be used which will not only form a protective film to counter-act the abrasive effect of dust, dirt, etc., but will function irrespective of temperature, moisture or weather conditions. This is a broad requirement; one, in fact, that very few compounded lubricants or greases will meet with any degree of success. Experience has proved that a straight mineral residual product of fairly non-fluid characteristics will give the most satisfactory results.

Where gears and chains are housed and capable of bath lubrication, however, the viscosity of the lubricant can be reduced to permit the use of a more fluid product, similar to a transmission lubricant. Heavier lubricants are advantageous in that their highly adhesive characteristics enable them to resist the effects of centrifugal force under higher speed conditions, provided they are sparsely applied, yet with sufficient frequency to insure maintenance of a suitable film. They are also more resistant to the washing-off effects of water.

Endless belt conveyors as used in some of the modern breakers run on idler and guide rolls, equipped with pressure grease-lubricated roller bearings. These are serviced at regular intervals with a special roller bearing grease which is heat-resistant and capable of withstanding oxidation and other conditions which might cause breakdown.

Printed in U. S. A. by
Edgar C. Rowe Co., Inc.
72 Washington St., N. Y. C.

(Continued from 2nd Cover)

Hoist Loaders

MOTOR BEARINGS AND GEAR CASE	Texaco Starfak Grease No. 2 or Texaco Marfak No. 2
HYDRAULIC SYSTEMS	Texaco Hydra Oil or Texaco Spica Oil
EXPOSED GEARS	Texaco Crater

Mine Cars and Locomotives

ELECTRIC MOTOR BEARINGS	
Waste Packed *(Oil Lubricated)*	Texaco Aleph Oil or Texaco Black Oil S
Ball or Roller Bearings *(Grease Lubricated)*	Texaco Starfak Grease No. 00, 2 or 3 or Texaco Marfak No. 2
ENCLOSED GEARS	Texaco Thubans
EXPOSED GEARS	Texaco Crater No. 1 or Texaco Marfak No. 1
AIR CYLINDERS	Texaco Aleph Oil
WHEEL BEARINGS	
Cavity Type Wheel	
Oil Lubricated	Texaco 747 Oil or Black Oil S
Grease Lubricated	Texaco Olympian Mine Car Grease No. 000
Ball and Roller Bearings	Texaco Olympian Mine Car Grease No. 00 or No. 1
ROLLER CHAINS AND SPROCKETS	Texaco 747 Oil or Texaco Black Oil S
OTHER PLAIN BEARINGS	
Oil Lubricated	Texaco 747 Oil or Texaco Black Oil S
Grease Lubricated	Texaco 747 Oil or Texaco Black Oil S
CONTROLLER FINGERS	Texaco Star F Grease No. 1

Mine Pumps

PLAIN BEARINGS *(Ring Oiled)*	Texaco Aleph Oil
BALL AND ROLLER BEARINGS	Texaco Starfak Grease No. 2 or Texaco Marfak No. 2

ABOVE GROUND

Ventilating Fans

BEARINGS *(Oil Lubricated)*	Texaco Alcaid Oil or Texaco Aleph Oil
(Grease Lubricated)	Texaco Star Greases
CHAIN DRIVES	Texaco Thubans

Wire Rope

GENERAL SERVICE	Texaco Crater A, No. 00 or No. 1
WATER CONDITIONS	Texaco Crater X or XX

Tipple Equipment

Breakers and Crushers

BEARINGS *(Oil Lubricated)*	Texaco Aleph, Altair, or Aries Oil
(Grease Lubricated)	Texaco Cup Greases or Vega Greases
GEARS AND CHAINS *(Bath Lubricated)*	Texaco Thubans
GEARS (Exposed)	Texaco Craters

Jigs, Rotary and Shaking Screens

BEARINGS AND GUIDES	Texaco Marfak or Texaco Cup Greases or Texaco Vega Grease No. 1 or No. 3 Texaco Aleph or Altair Oil
ECCENTRIC OR VIBRATING MECHANISMS	Texaco Marfak, or Texaco Cup Greases, or Texaco Vega Grease No. 1 or No. 3
RINGS, GEARS, DRIVING PINIONS, ETC.	Texaco Thubans
EXPOSED GEARS	Texaco Craters
GENERAL EXPOSED PARTS	Texaco 747 Oil or Black Oil

Conveyors and Picking Tables

ROLL BEARINGS	
Grease Lubricated — According to Type	Texaco Marfak Texaco Starfak Grease or Texaco Star H Grease No. 1
Oil Lubricated	Texaco Aleph or Altair Oil

SORRY, MISTER,

I'm in a Hurry!

IT'S A BIG JOB, producing coal for busy plants rearming America. And every single piece of coal mining equipment must perform at peak.

In prominent mines in every coal-producing State, coal cutters, loaders, mine cars, tipples and other equipment are kept on the job, giving smooth, efficient performance when lubricated with TEXACO.

Prominent among Texaco Lubricants is *Texaco Olympian Mine Car Grease. Olympian Greases* reduce maintenance costs by staying in the wheel cavities and bearings, lasting longer, reducing application time.

The outstanding performance that has made Texaco preferred in each of the fields listed in the panel has made it preferred in prominent mines in every coal producing State.

These Texaco users enjoy benefits that can also be yours. A Texaco Lubrication Engineer will gladly cooperate. Phone the nearest of more than 2300 Texaco distributing plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York, N. Y.

THEY PREFER TEXACO

★ More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

★ More locomotives and cars in the U.S. are lubricated with Texaco than with any other brand.

★ More revenue airline miles within the U. S. are flown with Texaco than with any other brand.

THE TEXAS COMPANY • TEXACO PETROLEUM PRODUCTS • DISTRICT OFFICES

ATLANTA, GA.	133 Carnegie Way	HOUSTON, TEX.	720 San Jacinto Street
BOSTON, MASS.	20 Providence Street	LOS ANGELES, CAL.	929 South Broadway
BUFFALO, N. Y.	14 Lafayette Square	MINNEAPOLIS, MINN.	706 Second Ave., South
BUTTE, MONT.	Main Street & Broadway	NEW ORLEANS, LA.	919 St. Charles Street
CHICAGO, ILL.	332 So. Michigan Avenue	NEW YORK, N. Y.	205 East 42nd Street
DALLAS, TEX.	2310 So. Lamar Street	NORFOLK, VA.	Olney Rd. & Granby St.
DENVER, COLO.	910 16th Street	SEATTLE, WASH.	3rd & Pike Streets

TEXACO

Indian Refining Company, 5 East Market Street, INDIANAPOLIS, IND.